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Closed Systems for Diallate

Proceedings of Workshop Conducted at Fargo, N.Dak., on September 17, 1980

CLOSED SYSTEMS FOR DIALLATE

Proceedings of Workshop
Conducted at Fargo, N.Dak.,
on September 17, 1980

Workshop organized and Proceedings
prepared by Alan G. Dexter and
John D. Nalewaja, Agronomy Department,
North Dakota State University, Fargo, N.Dak.
in cooperation with the National
Agricultural Pesticide Impact Assessment
Program (NAPIAP) and in support of
the USDA/State assessment activity
on the herbicide diallate

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WORKSHOP PARTICIPANTS

Gene Arnold
Plant Science Department
South Dakota State University
Brookings, SD 57006

Richard Behrens
Dept. of Agronomy and Plant Genetics
University of Minnesota
St. Paul, MN 55101

George Bowman
2210 Mill Road
North American Pump Corp.
Grand Forks, ND 58201

Robert Brazelton
Agricultural Engineering Dept.
University of California
Davis, CA 95616

Allan Cattanach
Extension Sugarbeet Specialist
North Dakota State University
Fargo, ND 58105

Albert J. Czajkowski
Monsanto Co.
800 North Lindbergh Blvd.
St. Louis, MO 63166

J. E. Dewey
Dept. of Entomology
Cornell University
Ithaca, NY 14853

Alan Dexter
Dept. of Agronomy
North Dakota State University
Fargo, ND 58105

Glynadee Edwards
Monsanto Co.
800 N. Lindbergh Blvd.
St. Louis, MO 63166

J. J. Feight
Ag Editor-Morrill Hall
North Dakota State University
Fargo, ND 58105

Stanford Fertig
Chief, Pesticide Impact Assessment
Building 1070
BARC-East
Beltsville, MD 20705

Harry W. Frazier
Monsanto Co.
800 N. Lindbergh Blvd.
St. Louis, MO 63166

D. Stuart Frear
USDA Metabolism & Radiation Lab.
North Dakota State University
Fargo, ND 58105

C. M. Gates
Nor-Am Agricultural Products
350 West Shuman Blvd.
Naperville, IL 60540

Manvel Green
Rural Route
St. Thomas, ND 58276

Alvin Hanson
Rural Route
Baker, MN 56513

David Hanson
Monsanto Co.
623 E. Main Ave., Suite 201
West Fargo, ND 58078

Gene Heikes
Extension Weed Scientist
Colorado State University
Ft. Collins, CO 80521

William Jacobs
Environmental Protection Agency
Office of Pesticide Prog. TS-767
401 M St. SW
Washington, D.C. 20460

B. K. Lilja
Extension Information
Morrill Hall
North Dakota State University
Fargo, ND 58105

Louis Lynn
Monsanto Co.
Dayton East Office Suite 420
9745 East Hampden Avenue
Denver, CO 80231

Steve Miller
Dept. of Agronomy
North Dakota State University
Fargo, ND 58105

Larry Mitich
Dept. of Botany
University of California
Davis, CA 95616

John Nalewaja
Dept. of Agronomy
North Dakota State University
Fargo, ND 58105

Cliff Nolan
USDA-SEA, Extension
Room 5547-S
Washington, D.C. 20250

William Pietsch
Asst. Director-Extension
North Dakota State University
Fargo, ND 58105

LeRoy Schaffner
Dept. of Agricultural Economics
North Dakota State University
Fargo, ND 58105

Galen Schroeder
Mobay Chemical Corp.
1233 North 4th Street
Fargo, ND 58102

Tom Schwartz
Weed Science Dept.
University of Wyoming
Laramie, WY 82071

Edward Schweizer
USDA-SEA, Crops Research Lab.
Colorado State University
Ft. Collins, CO 80523

Frank Serdy
Monsanto Co.
800 N. Lindbergh Blvd.
St. Louis, MO 63166

George Sinner
Rural Route
Casselton, ND 58012

C. L. Smith
USDA-SEA
Room 420A Administration Bldg.
14th & Independence SW
Washington, D.C. 20250

Oliver Strand
Dept. of Agronomy & Plant Genetics
University of Minnesota
St. Paul, MN 55101

Mike Warner
Rural Route
Halstad, MN 56548

Ralph Whitesides
Crop Science Dept.
Oregon State University
Corvallis, OR 97331

Allen Wiese
Texas A&M University
Bushland, TX 79012

Leon S. Wood
Dept. of Plant Science
South Dakota State University
Brookings, SD 57006

Leon J. Wrage
Dept. of Plant Science
South Dakota State University
Brookings, SD 57006

SUMMARY

The workshop consisted of presentations on closed system experiences in California and with the use of chlordimeform, on research results of diallate exposure during application, and a review of closed systems and associated use problems. The following is a summary of the discussion which related to the six objectives.

1) Develop a definition of a "closed system."

A liquid pesticide closed system is a system for removing a pesticide from its original container, rinsing the emptied container and transferring the pesticide and rinse solution to the application equipment in a manner that prevents harmful human exposure.

2) Identify essential components and categorize types of components of closed systems.

Essential Components

A. Container entry mechanism

   a. probe through container port
   b. puncture

B. Pesticide extraction from the container

   a. gravity flow
   b. suction

C. Pesticide transfer capability

   a. pump or venturi
   b. gravity
   c. other methods

D. Metering capability

   a. digital flow measuring device
   b. sight gauge
   c. calibrated probe
   d. direct volume measurement

E. Rinse system - liquid injection to flush original container, capture rinse solution, and transfer to application equipment.

The group believed that the specific design of closed systems should be left flexible as long as the completed system meets the definition and includes the essential components. Rigid requirements for closed systems could reduce innovations in design of future systems.

3) Estimate the expected acceptance of closed systems by farmers, chemical companies, container manufacturers and EPA.

Farmers, chemical companies and container manufacturers generally would prefer no closed system requirements. Many of the people in attendance at the closed systems for diallate workshop doubted that the risk from diallate use was high enough to justify cancellation of registered use of Avadex EC or the requirement for a closed system. However, the group would prefer the requirement for closed systems to cancellation of registered diallate uses.

Closed systems for diallate have potential advantages in reducing handling of full pesticide containers, improve measuring accuracy and simplifying container rinsing compared to open systems. Farmers could adapt to closed systems if closed systems are more economical, accurate and versatile than open systems. The closed system also would need to be easy and simple to operate for widespread usage.

4) Estimate the economic impact of adoption of various closed systems on farmers, chemical companies and container manufacturers.

Adoption of closed systems for diallate would be less expensive for farmers than converting to granular application.

Closed systems would be relatively less expensive to large farmers and custom operators than to small farmers.

Closed systems at a cost from \$300 to \$500 would not cause excess economic hardship even for most small farmers.

5) Estimate the effect of closed system adoption on diallate use, custom applicators, application accuracy and the environment.

Diallate use probably would not be reduced by a closed system requirement provided acceptable closed systems were easily usable and inexpensive.

Custom applicators would not be affected significantly by a closed system requirement for diallate because many custom applicators are presently using closed systems.

Diallate application accuracy could be improved by closed systems with accurate, reliable metering devices.

Closed systems would reduce potential spills and encourage rinsing containers which would reduce potential environmental hazards.

6) Evaluate expected reduction in exposure by various closed systems.

Calculations based on Monsanto research indicated that total lifetime exposure of the mixer/loader/applicator would be 83% lower with closed systems plus protective clothing as compared to open systems plus protective clothing. The main exposure route for diallate was dermal exposure during the mixing/loading operation. Use of rubber gloves alone reduced mixing/loading exposure by more than 90%.

INTRODUCTION

The code of Federal Regulations for the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) provides that rebuttable presumption against registration (RPAR) shall be issued if the Environmental Protection Agency (EPA) determines that the pesticide meets or exceeds any of the risk criteria relating to acute or chronic toxic effects set forth in the Regulations.

An RPAR may be rebutted by showing:

a) Anticipated exposure to an applicator or user, and to local, regional or national populations of nontarget organisms, is not likely to result in significant adverse effects;

b) The pesticide will not concentrate, persist, or accrue in man or environment to levels likely to result in significant chronic adverse effects; or

c) The EPA was in error in determining that the pesticide meets or exceeds risk criteria in the Regulations.

The EPA published a notice of RPAR of pesticide products containing diallate (trade name, Avadex) on May 31, 1977.

The "Biologic and Economic Assessment of Diallate" was prepared by the Diallate Assessment Team and submitted to EPA on September 12, 1977 as a part of the RPAR. The report was prepared by USDA, State Experiment Station and State Extension Service personnel. Dr. Stuart Frear, USDA-SEA, Fargo, ND and Dr. John Nalewaja, Dept. of Agronomy, North Dakota State University, Fargo, ND were co-leaders of the assessment team. Monsanto Agricultural Products Company provided extensive information on the acute and chronic toxic effects of diallate.

The EPA issued a preliminary notice of determination on the regulatory position towards diallate as a part of the RPAR procedure in April 1980. The FIFRA Scientific Advisory Panel met in June 1980 to review the EPA proposed regulatory decision regarding diallate.

The preliminary notice of determination from EPA proposed that all uses of emulsifiable concentrate diallate be canceled 2 years after the decision becomes final. Granular diallate would be substituted for the emulsifiable concentrate formulation.

Disadvantages of granules compared to the emulsifiable concentrate (EC) formulation were presented to the Scientific Advisory Panel by Manvel Green and Mike Warner, sugarbeet growers from the Red River Valley of North Dakota and Minnesota. These disadvantages were a) granules give less wild oats' control than the EC when applied in spring, b) many farmers do not own granular application equipment, c) diallate in granules is more expensive than in EC, and

d) tank mixing of granules of various pesticides causes non-uniform application; thus separate trips over a field are needed to apply each pesticide.

The Scientific Advisory Panel recommended that EPA consider allowing continued use of diallate emulsifiable concentrate in closed systems if such systems produced an acceptable reduction in exposure.

The objectives of the Workshop on Closed Systems for Diallate were to:

1) Develop a definition of a "closed system."

2) Identify essential components and categorize types of components of systems.

3) Estimate the expected acceptance of closed systems by farmers, chemical companies, container manufacturers and EPA.

4) Estimate the economic impact of adoption of various closed systems on farmers, chemical companies and container manufacturers.

5) Estimate the effect of closed system adoption on Avadex use, custom applicators, application accuracy and the environment.

6) Evaluate expected reduction in exposure by various closed systems.

Review of the Diallate RPAR and Triggers
Stanford Fertig, USDA-SEA
Report prepared from notes of the presentation

Much of the information presented by Dr. Fertig was included in the Introduction section.

The only RPAR trigger "tripped" by diallate was oncogenicity or tumor formation. The tumors were not classified as benign or malignant. Interested parties were given 105 days to respond to the diallate RPAR. EPA judged that the risks were not adequately rebutted; the RPAR proceeded through the risk/benefit analysis phase. The EPA issued Position Document 2/3 (PD 2/3) for diallate, which was submitted to the Secretary of Agriculture and the Scientific Advisory Panel. The PD 2/3 stated that the 2,400 diallate applicators were the primary persons at risk from continued diallate usage. The dietary levels of diallate were low and the risk to the consumer from dietary exposure was not significant.

Concern was expressed over the large differences between the USDA/State diallate benefits analysis and the EPA benefits analysis. The USDA/State team estimated about $7 million loss from the unavailability of Avadex, while the EPA estimate was only $3 million. The USDA and EPA have had meetings to resolve these differences.

Diallate Exposure under Various Field Conditions
Harry W. Frazier, Monsanto
Report is a summary of the slide presentation

Monsanto conducted research to evaluate and quantitate applicator exposure to diallate and triallate in 1977 and 1979. The research objectives were to determine exposures from various liquid and granule diallate and triallate application activities; to determine dermal deposition and inhalation during mixing, loading and application; and to develop methods of minimizing exposure and evaluate risk. The program was divided into a) pre-field validation of methods, b) field sample collection during diallate and triallate mixing and application and c) laboratory analysis of collected samples. The field treatment activities isolated and evaluated for applicator exposure were a) tank-fill and mixing of EC, b) hopper fill with granules; c) field application with boom-sprayer or spray-harrow using open cab or closed cab; d) incorporation; and e) reentry walk-through.

Problems encountered in the 1977 research were cross-contamination between various steps and unfavorable weather. However, the results indicated that the potential for dermal exposure far exceeded the inhalation route, especially in the mixing/loading steps. The primary exposure was to the hands. Rubber gloves reduced exposure by about 90%. The mixing/loading step resulted in 90 to 95% of the total exposure.

Improved procedures in the 1979 research included new paper coveralls for each operation to eliminate cross contamination. Two air sampling systems were employed for comparison. The final results of the 1979 research should be available after October 1980.

The premises used in exposure calculations were a) normal application procedures, b) rubber gloves used during tank or hopper fill, c) coveralls worn during tank or hopper fill, d) absorption was 10% of dermal deposition, e) exposure was proportional to total pounds of diallate used, f) 1,150 applicators treated 110 acres each, g) applicators live to 70 years and are exposed for 40 years, and h) applicator weight 70 kg. Actual measurements were used to determine exposure with the open system while calculated values were used for the closed system.

The maximum face-neck exposure was 3.7 ug/cm^2 for the open system and protective clothing. Maximum face-neck exposure with a closed system and protective clothing was calculated as 0.419 ug/cm^2, an exposure reduction of 89%. Lifetime use exposures for open and closed systems are given in the following table.

Lifetime applicator exposure to diallate with use of protective clothing.

	Dermal		Inhalation		Total	
	Constant lifetime dosage (ug/kg bw/day)	Lifetime dietary dose (ppm)	(ug/kg bw/day)	(ppm)	(ug/kg bw/day)	(ppm)
Open system	0.041	1.09×10^{-3}	0.0025	6.7×10^{-5}	0.0435	1.16×10^{-3}
Closed system	0.0047	1.26×10^{-4}	0.0025	6.7×10^{-5}	0.0072	1.92×10^{-4}

The dermal route contributed about 15 times more exposure than inhalation. Dermal exposure with closed systems was 89% less than with open systems. The inhalation exposure levels were comparable with open and closed systems since nearly all inhalation exposure occurred during application/incorporation, not during tank-fill. Total exposure was 83% lower with closed systems as compared to open systems.

Toxicity Testing Discussion led
by Frank Serdy, Monsanto Company

Test animals are typically treated with three levels of the technical grade pesticide and untreated animals are included for reference. The pesticide is mixed with the feed or administered with a stomach tube if the pesticide is unstable or unpalatable. The technical material is tested because all other components of the formulation have been tested previously and appear on the inert exempt list. The objective of the testing is to establish a no effect level (NOEL) for the pesticide. The NOEL is expressed in mg pesticide/kg body weight/day. Depending on the relative toxicity of the pesticide, either a 100 or 1000 fold safety factor is used in determining the acceptable daily intake.

The exposure levels for a pesticide include intake through the diet and intake through exposure while applying the pesticide. The risk of diallate exposure through the diet is negligible. Technical diallate has never been detected as a residue in any food crop.

A key area of disagreement in the science of toxicology concerns the ability to set a NOEL for a carcinogen. Some toxicologists believe in the one molecule or one hit theory which says that any level of a carcinogen can cause an effect and that a NOEL cannot be established. Other toxicologists believe that low levels of a carcinogen do not cause an effect and that a NOEL can be established. The EPA presently seems to be accepting the one molecule theory and as a result are making conservative assumptions that may err on the side of safety.

The Use of Closed Systems for Aerial Applications of Chlordimeform

Charles Gates, Nor-Am Agricultural Products

Chlordimeform is an insecticide used principally in cotton for control of the cotton bollworm and tobacco budworm and is produced by Schering AG, Berlin, West Germany and Ciba-Geigy, Ltd., Switzerland. In the U.S. chlordimeform is sold by NOR-AM Agricultural Products, Inc. and Ciba-Geigy Corporation, under the trade names Fundal and Galecron, respectively.

In 1976 it became apparent, from toxicology tests being conducted in Switzerland, that chlordimeform might be carcinogenic to certain strains of laboratory mice. This information prompted Ciba-Geigy, Corp. to determine the level of exposure that might be expected by workers on aerial application sites. A typical site was chosen and the workers monitored.

Chlordimeform is rapidly absorbed through the skin and almost totally excreted through the urine. Therefore, analysis of daily urine samples can give an accurate picture of the exposure of an individual to the compound. Urinalysis of the individuals at the chosen site showed surprisingly that the pilots had very little or no exposure to chlordimeform. The mixer/loaders and flagmen, however, showed an average daily urine content of about 3 PPM, indicating that they were being exposed through skin contact. These same people then were asked to wear protective clothing, consisting of a rubber apron, rubber gloves, long sleeved shirt, long trousers, leather boots, cloth cap, goggles, and respirator. Samples taken from these same people showed that the protective clothing had reduced the average daily urine content to 0.84 PPM.

Late in the season in 1976, both manufacturers decided voluntarily to withdraw chlordimeform from the market pending completion of the ongoing toxicology test.

During 1977, four test sites were established with large cotton planting-seed producers to test the efficacy of a closed system to reduce further the exposure of applicator personnel to chlordimeform. The system used was supplied by Soil Serve, Inc., utilizing the suction probe for transferring chlordimeform from the drum to the aircraft. Workers were required to continue the use of protective clothing as previously described. It was found, from the analysis of 275 samples, that the closed system had reduced the exposure about tenfold. The average daily urine sample from the mixer/loaders contained 0.075 PPM during these tests.

On completion of the toxicology tests in late 1977, it was decided to reintroduce chlordimeform to the cotton market as a restricted use pesticide in 1978. Its use would be restricted to aerial applicators, equipped with approved closed systems, and who agreed to participate in a closely monitored program. About 20 sites were chosen by the two companies. Since the states involved were not prepared to describe an approved closed system, NOR-AM and Ciba-Geigy chose to certify the sites themselves.

It had been determined that the Soil-Serve system, while effective, was too complicated for the unsophisticated "summer help" used by aerial applicators in the mid-south. Ciba-Geigy therefore opted to use a modified bulk chemical system and NOR-AM decided to use the Goodwin Closed System "Can Opener" as the basis for their system. Careful monitoring of all workers was conducted, confirming our previous experience. Five thousand samples from mixer/loaders were analyzed in 1978, of which 95% had an average daily urine content of <0.1 PPM chlordimeform.

After some initial skepticism, we found broad acceptance of the Goodwin "Can Opener" system by applicators. Continued monitoring by urinalysis in 1979 and 1980, of several hundred sites, has shown that chlordimeform can be applied with minimum exposure of applicator personnel.

Discussion

The Goodwin "Can Opener" system costs approximately $725. The 3 to 15 second rinse of the empty cans removed 99.9% of the chlordimeform from the cans. Drip-free disconnects are an important part of a closed system.

Based on feeding studies, a total of 30 PPM in the urine for one year would be safe. None of the persons studied in 1978, 1979, or 1980 exceeded this level.

Closed Systems in California

R. W. Brazelton, Dept. of Agric. Engineering
University of California, Davis

California requirements for the design and use of closed systems are adequately presented in Department of Food and Agriculture, "Liquid Pesticide Closed System Requirements" (Attachment 1). It should be noted that the list of commercial systems declared to meet the criteria mentions all systems reviewed by the department. Since that review, technical and market problems may have caused one or more of these systems to be discontinued.

A rather detailed discussion of system history and use experience was presented in a paper prepared for the 1980 California Weed Conference entitled "Closed System Update" (Attachment 2). A brief summary of this paper follows.

Studies of the nature of illnesses and injuries attributed to pesticides in 1973 indicated, as might be expected, that workers most directly in contact with pesticides as mixers and loaders, ground applicators, flaggers, etc., were most frequently involved. Continued studies through 1979 (Table 1) indicate a decline in this injury and illness rate. Closed systems were first discussed in worker safety regulations in 1974, but formal enforcement did not begin until January 1978.

TABLE I

OCCUPATIONAL PESTICIDE ILLNESS *

TOTAL NUMBERS BY EMPLOYMENT

	1973	1974	1975	1976	1977	1978	1979**
PILOTS	14	17	7	8	7	8	1
FLAGGERS	20	6	16	14	15	24	9
MIXERS/LOADERS	165	141	143	122	143	142	132
AGR. GROUND APPLICATORS	424	225	264	254	236	163	161
FIELD WORKER RE-ENTRY	157	112	167	156	184	95	53
GARDENERS (COMMERCIAL)	66	103	106	159	155	138	92
NURSERY AND GREENHOUSE	112	73	90	119	72	69	48
FUMIGATOR (FIELD)	71	29	22	14	16	20	21
MACHINE CLEAN AND REPAIR	22	28	40	26	33	21	19
TRACTOR DRIVERS, IRRIGATORS	—	23	22	30	29	20	23
DRIFT EXPOSURE (PERSONS NEARBY)	26	22	31	29	30	44	19
							Other 30**
TOTAL ALL OF AGRICULTURE	1077	779	908	931	920	744	608
TOTAL OTHER THAN AGRICULTURE	397	378	435	521	598	450	411
GRAND TOTAL FOR YEAR	1474	1157	1343	1452	1518	1194	1019
% BY AGRICULTURE	73	67	68	64	61	62	60

*FROM DOCTOR'S FIRST REPORT OF ILLNESS AND OTHER MEDICAL REPORTS EMPLOYEES ONLY

**1979 Agriculture includes for the first time, animal applicator and self employed categories.

Specific studies of the workforce at large commercial application firms have indicated substantial reduction of cholinesterase depression problems where closed systems were used for handling Category 1 (word DANGER on label) liquid pesticides. It is also highly probable that some of the decline in injuries and illnesses can be attributed to the substantial increase in training of workers in safe handling procedures.

Early systems suffered substantially from failure of seals, gaskets and hoses. It became obvious that such parts must be designed to be compatible with pesticides to be encountered. Early negative response by some users disenchanted with what was viewed as excessive regulation was often offset by successful operation of such systems by other users. Some systems proved too complex and/or expensive.

By 1979, numerous applicators were successfully operating closed systems which generally were custom built utilizing the most desirable components of perhaps several manufacturers combined with some homemade elements. Some factors to consider are:

1. There are two basic system types. Pesticide containers cannot be pressurized so the material must be extracted either by gravity or by vacuum. Gravity systems such as the Goodwin systems or Captain Crunch work very well except that they cut the container so that the entire contents is emptied. The vacuum method employs some vacuum source such as a vacuum pump or suction from a regular pump.

2. Highly viscous materials are difficult to move with a vacuum system (Figure 1). For best results a container suction probe should approach one inch in diameter and be operated with at least 15 inches of mercury vacuum.

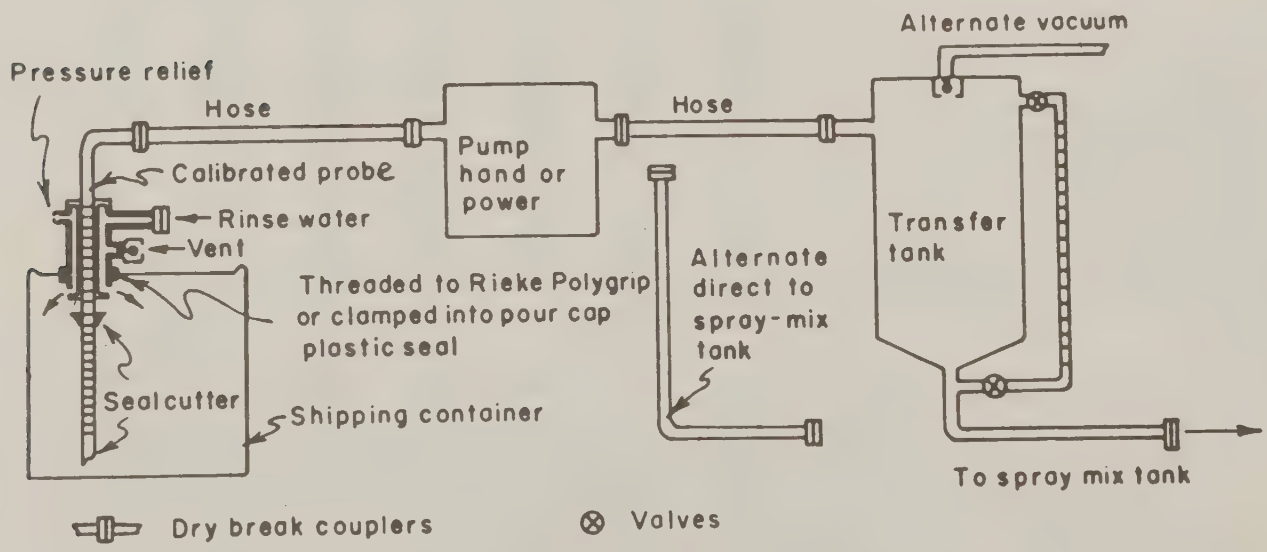

FIGURE 1

3. Rinse water pressure must be carefully controlled to avoid probe blowout or can rupture.

4. Seals, gaskets, hoses, and similar parts must be made of materials reasonably compatible with the pesticides to be used.

5. Excellent maintenance is a key to the successful use of closed systems. Systems should always be thoroughly rinsed after use, for if the pesticide is left in the system, the possibility of damage to system parts is increased greatly.

6. The system or system components must be carefully selected to assure handling capabilities appropriate to the type of operation contemplated.

7. Gravity feed or venturi suction systems seem to be more trouble-free than systems involving special pumps, vacuum systems, etc.

8. Closed system operators must have adequate training and generally may have to be selected for a higher degree of skill than common labor often used in the past.

Discussion

There were no pesticide-related deaths in agriculture in California from 1973 through 1979. Thirty-eight people were killed in tractor accidents in one year alone.

A pressure system of moving and handling pesticides will not work in agriculture because pesticide containers are not pressure vessels and could rupture under pressure. Thus, the closed systems used in agriculture in California are either can opener or suction types. Plastic liners in cans may cause problems for some can opener types. The wide diversity of types of pesticide containers is the most difficult engineering problem with the suction type of closed system. Forty-seven different kinds of containers were counted in California. These containers also have several types of openings with different sizes and thread types.

The pressure on the rinse system must be controlled to prevent rupture of pesticide containers. The storage of partially empty pesticide containers is a problem. The probes are expensive, so most operators do not like to leave probes in a partially empty container. Removing the probe could cause exposure to the operator. One company is making a disconnect probe to help solve this problem.

Good operators who run a clean, neat business usually have good results with closed systems. Sloppy operators often have problems making closed systems work properly. Maintenance and keeping the system clean is very important to successful operation. People using closed systems in California had less reduction in cholinesterase levels than those using open systems.

California closed system regulations apply only to employees. A farmer can legally load Category I pesticides without a closed system if the pesticide is for his own use. Applying any future closed system requirement to diallate on an "employee only" basis may get the program started on an effective commercial level and yet bypass much of the anti-regulation response from private owners.

State of California

Department of Food and Agriculture

CRITERIA FOR CLOSED LIQUID PESTICIDE SYSTEMS

1. The liquid pesticide shall be removed from its original shipping container and transferred through connecting hoses, pipes, and/or couplings that are sufficiently tight to prevent exposure of any person to the pesticide concentrate, use dilution, or rinse solution.

2. All hoses, piping, tanks, and connections used in conjunction with a closed liquid pesticide system shall be of a type appropriate for the pesticide being used and the pressure and vacuum to be encountered.

3. All sight gauges shall be protected against breakage. External sight gauges shall be equipped with valves so that the pipes to the sight gauge can be shut off in case of breakage or leakage.

4. The closed system shall adequately measure the pesticide being used. Measuring devices shall be accurately calibrated to the smallest unit in which the material is being weighed or measured. Consideration must be given to any pesticide remaining in the transfer lines as to the effect on accuracy of measurement.

5. The movement of a pesticide concentrate, beyond a pump by positive pressure, shall not exceed pressure of twenty-five (25) pounds per square inch.

6. A probe shall not be removed from a container except when:

   (a) The container is emptied and the inside of the container and the probe have been rinsed in accordance with 8;

   (b) The Department of Food and Agriculture has evaluated the probe and determined that by the nature of its construction or design it eliminates significant hazard of worker exposure to the pesticide when withdrawn from a partial container; or

   (c) The pesticide is used without dilution and the container has been emptied.

7. Shut off devices shall be installed on the exit end of all hoses and at all disconnect points to prevent leakage of pesticide when the transfer is stopped and the hose removed or disconnected.

   (a) If the hose carried pesticide concentrate and has not been rinsed in accordance with 8, a dry coupler that will minimize pesticide drippage to not more than 2 milliliters per disconnect shall be installed at the disconnect point.

   (b) If the hose carried a pesticide use dilution or rinse solution, a reversing action pump or a similar system that will empty the hose and eliminate dripping of liquid from the end of the hose may be used as an alternative to a shut off device.

8. When the pesticide is to be diluted for use, the closed system shall provide for adequate rinsing of containers that have held less than 60 gallons of a liquid pesticide. Rinsing shall be done with a medium, such as water, that contains no pesticide.

   (a) The rinsing system shall be capable of spray rinsing the inner surfaces of the container and the rinse solution shall go into the pesticide mix tank or applicator vehicle via the closed system. The system shall be capable of adequately rinsing the probe (if used) and all hoses, measuring devices, etc.

   (b) A minimum of 15 pounds' pressure per inch shall be used for rinsing.

   (c) The rinsing shall be continued until a minimum of one-half of the container volume or 10 gallons, whichever is less, of rinse medium has been used.

   (d) The rinse solution shall be removed from the pesticide container concurrently with introduction of the rinse medium.

   (e) Pesticide containers shall be protected against excessive pressure during the container rinse operation. The maximum container pressure shall not exceed five (5) pounds' pressure per square inch.

9. Each commercially produced closed system or component to be used with a closed system shall be sold with a complete set of instructions on its operation. These instructions shall consist of a functional operating manual and a decal and/or system of decals placed on the system covering the basic operation.

   The instructions shall also describe any restrictions or limitations relating to the system such as pesticides that are incompatible with materials used in the construction of the system, types (or sizes) of containers or closures that cannot be handled by the system, any limits on ability to correct for over measurement of a pesticide, or special procedures or limitations on the ability of the system to deal with partially emptied containers.

These criteria do not preclude closed mixing systems utilizing procedures other than those outlined above. Questions concerning the ability of other procedures to meet California's closed mixing system requirement may be directed to:

Department of Food and Agriculture
Pesticide Enforcement
1220 N Street, Room A-170
Sacramento, California 95814
(916) 322-5032

Attachment 1

Liquid Pesticide Closed System Requirements

William A. Betts
Department of Food and Agriculture
State of California

Hand pouring has been found to be the most hazardous activity involving the handling of highly toxic pesticides and has resulted in many serious human illnesses.

California's pesticide worker safety regulations require that employees who handle liquid pesticides displaying the signal word "DANGER" on the label shall use "closed systems." This requirement applies to all employees except those involved in structural, home, institutional, or industrial pest control activities.

"Closed system" is defined as "a procedure for removing a pesticide from its original container, rinsing the emptied container, and transferring the pesticide and rinse solution through connecting hoses, pipes, and couplings that are sufficiently tight to prevent exposure of any person to the pesticide or rinse solution. Rinsing is not required when the pesticide is used without dilution. The system's design and construction shall meet the Director's closed system criteria."

Based upon evaluations of systems already in use in California, the use of closed systems should:

1. Significantly reduce the number of human illnesses attributed to pesticide exposure.
2. Reduce the number of cholinesterase tests needed.
3. Reduce the need and expense for protective clothing and equipment.
4. Reduce medical expenses and insurance costs associated with illness and disability associated with exposure to pesticides and lifting heavy containers.

Firms having closed systems or components commercially available that have been found to meet California's requirements are listed on page 18.

To meet California's requirements, a closed system must meet the attached criteria. Components must be accompanied by directions clearly indicating how the component is to be used in the construction of a closed system.

This is a partial list of closed system manufacturers

Specialty Steel Fabricating (Goodwin System)
2314 S. Hollenbeck Road
Stockton, CA 95206
Jim Soares (209) 463-6082

Coastal Ag-Chem
1015 East Wooley Road
Oxnard, CA 93030
Earl Griffin (805) 487-4961

Soilserv Incorporated
1427 Abbott Street
Salinas, CA 93901
Hugh Shaw (408) 422-6428

Blackwelders (Meter-Matic)
101 Blackwelder Drive
Rio Vista, CA 94571
John Kincheloe (707) 374-6441

Protect-O-Mfg. Company
Star Route, Box 8337, West Hwy. 126
Redmond, OR 97756
Cal Butler (503) 548-5446 or 382-6886

Terminator Products (Calibrator)
1550 - 105th Avenue
Oakland, CA 94603
Jim Stevenson (415) 638-3654

Squire Farm Service
2931 Tully Road
Hughson, CA 95326
Ralph Squires (209) 883-2283

FMC Corporation
Agricultural Machinery Division
222 East 14th
Ripon, CA 95366
Dan Nelson (209) 599-4147

Pneumatic Conveyor Systems (Vacutrans)
P. O. Box 8404
Long Beach, CA 90808
Dan Freeman (213) 421-5687

Cherlor Mfg. Co. Inc. (Chemprobe)
P. O. Box 2174
Salinas, CA 93902
Dave Anderson (408) 422-5477

Massey Aviation
P. O. Box 716
1402 S. Lexington
Delano, CA 93215
Gerry Massey (805) 725-8750

Strong Steel
P. O. Box AK
Ventura, CA 93001
Sonny Boynton (805) 648-6841

D and D Closed Systems
P. O. Box 997
Blythe, CA 92225
Dan Riggi (714) 922-3806

Captain Corporation (Captain Crunch)
P. O. Box 384
Sheldon, IA 51201
Jerry Ralston (712) 324-4633

Attachment 2

CLOSED SYSTEM UPDATE[a]

R. W. Brazelton, N. B. Akesson, and K. T. Maddy
January 1980

INTRODUCTION

The 1979 study reported on here involved a plan to visit pest control applicators statewide representing all types of agriculture, ranging from small private applicators to large commercial firms. Such visits were to get a broad base view of how closed systems were being used and to evaluate the implementation of the closed system requirement. The University also engaged in studying use of cotton defoliants to determine potential human exposure factors, and the Department of Food and Agriculture conducted studies of human exposure of mixer/loaders, flaggers, and pilots to DEF and Folex during the cotton defoliation season.

Time and space do not permit an extensive discussion here of the history of closed system hardware design and detailed descriptions of all systems designed for use in the state. It is assumed that such background material is already familiar to the majority of industry personnel.

A BRIEF HISTORY

In the late 1960s and early 1970s, the loud complaints and often widely emotional accusations of large numbers of serious illnesses and deaths due to exposures to pesticides made it rather clear that an in-depth effort should be made to ascertain the facts. If, indeed, thousands of workers were being poisoned and some 800 killed each year by pesticides, as claimed by one uninformed widely quoted source, it became clear that the public should know what pesticides were involved, what the specific circumstances of the accidents were, and above all, what the doctor's first report of injury had to say about each incident.

The 1973 Study

What was actually happening in the field? It seemed quite logical to determine the nature and cause of the problems if one is to plan a program which could eliminate such accidents in the future. The Department of Food and Agriculture and the Department of Health assembled a team and studied many of the "doctor's first report of injury" filed in 1973. The team engaged in on-site investigations and, for the first time, assembled meaningful data on how the exposure occurred and the pesticide involved in most of the reported illnesses. The final analysis quickly pointed to proof of the obvious--persons working in close personal contact with the more toxic pesticides were injured at the highest rate: loaders, mixers, flaggers, ground applicators, greenhouse and nursery applicators, field workers, and others. The study revealed that occupational deaths from pesticide exposures were rare, and that about 1,500 occupational exposures to pesticides could be accounted for per year.

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[a]Prepared for presentation at the California Weed Conference in Sacramento, California, January 24, 1980.

The 1974 Worker Safety Regulations

The 1973 study results clearly pointed to the need for attacking certain problem areas, so by 1974 worker safety regulations were well underway. In these, the first requirements for the use of closed systems appeared. These were later implemented, and enforcement began January 1, 1978, and has continued. Basically, the Department of Food and Agriculture indicated that no change in this concept is contemplated.

HUMAN EXPOSURE

The purpose of closed systems is to reduce human exposure--to provide a method whereby technical Category I liquid chemicals can be removed from their original containers and introduced into mixing systems for dilution to field use concentrations without exposing the worker. How well have they done this?

To be sure, closed system failures have exposed workers, and failure to use the required systems has led to injury of others. Injuries have not been reduced to zero. However, two large scale ground application firms report that they maintain a regular cholinesterase testing program as required by regulation on all of their high exposure employees, and attempt to operate exclusively with closed systems. Their records indicate almost total elimination of cholinesterase depression problems and, hence, success, in view of earlier experience in that area.

In addition to noting such experiences by commercial pest control firms, the Department of Food and Agriculture, the Department of Health, and the University of California have all been involved in human exposure testing and development of operational techniques to reduce drift and deposit hazards.

The most extensive direct exposure testing was done in 1979. The data collected are currently undergoing analysis, and results are not yet available. The annual studies of "doctor's first report of injury" have indicated, however, that in the direct contact occupations, as noted above, there does appear to be a reduction of illnesses and injuries, but, so far, it is hard to tell whether closed systems are accomplishing this or if it is due to changes in pesticides used, to better education, or to more intensive enforcement. This paper will not pursue the human exposure issue, but rather will concentrate on hardware.

HARDWARE DEVELOPMENTS

As is common today with legislation and regulations, the closed system regulations became effective without benefit of prior equipment development. However, a problem of urgency did exist and, actually, some 4 years elapsed between the initial announcement of such a requirement and the declared January 1, 1978 enforcement date.

Theoretically, this should have allowed "industry" to produce an effective closed system, but, in reality, there was and is no "industry" dedicated to closed system production. Systems produced came from in-the-field chemical applicators--homemade, if you will--without benefit of massive research organization and funding, and those problems which have been encountered reflect

this approach. Regulatory agencies must face the fact that, nationwide, the emphasis (especially monetary emphasis) has been on regulation development and enforcement, not on development of properly engineered hardware to solve the problems of closed systems, drift control, and other hardware-related solutions to current problem areas in pesticide application.

The early closed systems requirements caused aerial and ground applicators to begin designing their own systems in their hangers and shops. Soon a number decided on production and marketed their units after they received the implied "approval" of the Department of Food and Agriculture. Units were widely exhibited and in sales demonstrations worked well with water as a demonstration medium. In the hard, cold light of in-the-field use, when subjected to the highly corrosive or chemically devastating materials in the hands of routine labor, problems began to surface and dissatisfaction became widespread--not necessarily, as it turned out, entirely the fault of all of the systems.

As a result, a number of the so-called "approved" systems are no longer for sale. A detailed analysis of problems encountered confirms some problems, but not necessarily all.

THE DECEMBER 12, 1978 DEPT. OF FOOD & AGRICULTURE REVIEW

On this historic occasion, representatives of every segment of the industry concerned were invited to Sacramento to discuss a year's experience with closed systems, to air their complaints, tout their successes, and in general to establish the state of the art for the record, The 2-hour "debate" was a very lively one, abounding with accounts of system failures, complaints of company service policies, regulation shortcomings, chemical problems with viscosity, and chemical destruction of seals, gaskets and hoses, problems with enforcement, etc. The final report is a matter of record. Suffice it to say that it was extremely productive and items identified assisted in developing follow-up to these points during the 1979 tour to be discussed here.

THE 1979 VISITS

Travels around the state during all of 1979 made it possible to visit the facilities and look at the hardware of a wide range of chemical applicators. Visited were small "Mom and Pop" nursery operations using a single unit on a very small and infrequent scale, some of the state's largest citrus operations, vast acreages of vegetable crops, and a wide variety of aerial operations from the Imperial Valley to the Northern Sacramento Valley.

Reports by users fairly consistently covered most of the comments made in the December 1978 "Closed System Summary" meeting---some troubles with seals and gaskets---some with hoses---complaints about certain chemicals---and yet, some very interesting facts came to light.

A visit to some operators found that they had purchased well-known closed systems. They had tried using these and had experienced severe troubles. Components failed repeatedly. Operators had been inadvertently sprayed when the

probe failed, etc. Nothing worked, so they had either junked the systems or modified them. Elsewhere a large scale operator was encountered using one of these commercial systems. Everything was working perfectly and no problems existed. In fact, since he had started using it, to quote him---"cholinesterase testing of my men has been excellent and I've only had to pull one man off the job, and he had not been using the closed system." A further comment was, "We like it so well, we use it on everything---not just Category I materials."

RULE OF THUMB

When one visits large numbers of chemical applicators across an entire state, several persons who have done so are in agreement that it may be possible to simply drive up to the operational area of such places and immediately estimate what to expect of their closed system just by the appearance of the facility. If the yard is full of muddy chuckholes with empty chemical cans lying around and there are piles of old equipment--rusting and covered with cobwebs and dust--the next encounter will probably be massive piles of old containers in mixed disarray not far from a chemical covered loading dock and more evidence of poor housekeeping. Before even entering the guess is that this operator is having a problem with his closed system and when the subject is brought up, his colorful language often quickly confirms the situation. This is not always true, since some operations that appear like this on the surface do concentrate on keeping critical operational equipment in excellent condition while giving secondary effort to housekeeping based on management priorities.

On the other hand, if a visit reveals a sharp, clean and well organized operation, with good equipment being worked on by men in clean coveralls on a good concrete or packed gravel pad, or in a neat and well organized hanger, it can be guessed ahead of time that the equipment will often include a properly performing closed system (usually homemade, or partially so) which has been working with very little difficulty except for basic viscosity problems and other specific chemical problems.

SOME SPECIFICS

Vacuum

Unless a gravity feed system is used, the only practical means of emptying a container is by sucking the material out, either with a basic vacuum system or the vacuum generated by a pump, since existing containers cannot be pressurized. Such equipment usually develops trouble when chemicals attack and swell or destroy "O" rings, other seals and gaskets. The word "usually" is used because this sort of failure does not always occur. This will be discussed further.

Probe Troubles

Operators have had suction probes blow out in their face or cans rupture. This can often be traced to rinse water control. Water supply pressures may range up to 80-100 psi and unless rinsing is very positively controlled, such accidents are a certainty. Another cause is inadequate training---the operators open and close valves in an improper sequence.

Probes that can't be removed because of use of only a partial container do present can balance problems and difficult handling, as well as excessive capital investment in large numbers of probes required.

One probe, the Chemprobe, appears to be very widely accepted. It has the advantage of an internally retracting design which permits it to be used for partial container extraction and withdrawn from the container for use elsewhere. One fault perhaps lies in its small diameter which, like most probes, restricts high volume handling of very thick chemicals. A very excellent vacuum system, often venturi-generated, can assist in overcoming that problem.

Can Rinse

Most systems provide for introduction of rinse water which will then be transferred to the mix tank. Most work well when used properly. There have been a few problems. When using a system that the system design is intended to slice open the entire container, like the Goodwin system does to drain and rinse it, some difficulty has been encountered with plastic can liners which do not slice properly and the liner tends to resist rinsing and draining.

In some operations, 30-gallon drums or larger are used at a central location to fill "concentrate" supply tanks on spray rigs at night for the next day's operations. This can be done by inserting a probe long enough for the drum and pumping the concentrate into spray rig supply tanks, but the question is how to rinse and dispose of the drums since, in this procedure, an operational mix tank is not available. Operators faced with this problem recognize it and are working hard to improve this situation.

Seals, Gaskets and Hoses

These seem to cause the major problems. Supracide has been labeled as the worst villain by many users. It is said that it can't be held in anything and is claimed to destroy hoses, gaskets and "O" rings. Some other chemicals have a similar reputation. This reputation presents a dilemma, because in one area of California, Supracide is being used daily in season in large quantities with no difficulty at all. There it is pumped from drums through an ordinary electric pump and delivered to the tank through over-the-counter petroleum hose with no long term evidence of any problem. Faced with this kind of evidence, any investigator might begin to question. This brings the discussion to the next key question.

Service and Maintenance

The wide range of closed systems used with results ranging from total failure to complete success with identical hardware causes one to wonder 'why the difference'. It has been observed that success or partial success in the use of closed systems seems to relate to a great degree to operational techniques except in a few cases where the system did prove to be totally inadequate. There is no doubt that some problems remain unresolved, but by and large, an effective operator seems to be able to work with closed systems with a relatively high degree of success. The key to his success appears to be an extension of knowledge used in other operations.

For example, an aircraft engine is quite sophisticated. It requires highly qualified care and periodic maintenance (mandated by FAA regulations) and such power plants seldom fail. Some operators have recognized that successful closed systems must be handled the same way; they recognize this and work accordingly, so that the closed systems under their control perform as required with little difficulty except with high viscosity materials.

A prime problem in closed system use involves system corrosion and seal and gasket failure. If an operator uses the system to transfer a quantity of highly toxic (and corrosive) chemical, and then with no further attention departs to do the spray job, leaving the closed transfer system filled with the technical material to stand for hours, days, or weeks, disaster will strike. The next time he attempts a transfer, seals will leak and the entire system may fail because the corrosive and toxic material has been working on all vulnerable parts during the downtime.

On the other hand, the informed operator will thoroughly rinse and clean his system immediately after transfer use. In storage, the seals, "O" rings, gaskets and hoses then are exposed only to rinse water, and thus, are more likely to be ready to perform as usual when again called upon to do so.

There may be exceptions, but since Supracide can be handled without problems by some operators, then it seems quite reasonable that a properly designed and maintained system should survive in use with most agricultural chemicals.

System Design

Let's face it. Category I liquid pesticides are not distilled water. To carry and store such material successfully, initial cost must be ignored in favor of long time maintenance and performance. The rule is "Go stainless!" It costs more, but the list of satisfied customers grows daily. One operator put together an entire stainless system, but could not get one elbow in stainless and because of work schedules substituted carbon steel. This is where the first leak occurred.

Containers

The neglected area of container design remains a basic cause for failure to attain totally successful closed system handling of toxic chemicals. A container must be entered to extract its contents, but because of the toxic contents, this must be done in a manner to assure no exposure to the worker. The catch lies with the several dozen container designs. Given a good, properly designed standardized, container closure, any good engineer can design an effective and safe means of utilizing it to feed a closed system. This has been done decades ago in other industries--why not now in agriculture? It remains a national problem of considerable magnitude.

CONCLUSIONS

Closed system requirements are currently firm and the Dept. of Food and Agriculture indicates that no change is contemplated.

1. No commercial closed system in "as marketed" condition seems to be totally successful for all operations. The most successful operators utilize the best features of several and build up a system to meet their particular demand with a high degree of success.

2. Some chemicals are not adaptable to high speed transfer to meet large scale operational requirements--examples are high viscosity flowables. A partial solution involves the use of excellent vacuum (15" of mercury or more) and large diameter probes (1" or more). However, unless the viscosity problem can be solved, operators will still resort to hand pouring of such materials.

3. The most important key of all is effective operation and maintenance. These chemicals are highly destructive and should never be allowed to remain in the system. Thorough and immediate rinsing and good maintenance are keys to success.

4. Gravity feed or venturi suction systems appear to be much more trouble-free than systems involving special pumps, vacuum systems, etc.

5. Data collected to date tend to indicate some reduction in injuries. Some specific operators attribute this success to reduced exposure because of the successful use of closed systems. However, there is still sufficient avoidance of the use of closed systems that clear statistical proof is not yet available.

6. Laws and regulations must be enforced if they are to attain effectiveness. The problem of the extensive disregard for the 55 mph speed limit is an example. If regulations are to be effective, and not even this has been positively proved, the closed system regulation must be enforced. There is current evidence that closed system useful effectiveness varies with enforcement. Hand pouring still occurs and with high viscosity materials may be unavoidable until new techniques of formulations are developed.

7. California is now encountering a complex problem with the newly changed pesticide regulations. These must be enforced by expanded county agricultural commissioner offices which must be substantially expanded to handle such a job. This will require a multi-million dollar budget increase and the hiring of more staff personnel in all counties to handle the increased workload. There is, at this time, no assurance that such funding will be available and even if available, there is a question as to whether enough qualified personnel can be found immediately to fill such positions. With the new and complex regulations for all elements of pesticide enforcement, closed system enforcement must share the need for attention with other areas covered by the large volume of "re-evaluated" pesticide regulations.

8. The smart operator will continue to perfect and use his closed system, because if he can do it and still maintain timely performance, he knows he can benefit. He will do even better if the government and container industry can get off dead center and standardize containers to make the closed systems work more effectively.

9. It would appear that there are a sufficient number of satisfactorily operating systems in the state to prove the point that in a business faced with regulations that are not apt to go away soon, the ingenuity so common to the success of agriculture in California must be called upon for the answer.

10. Closed systems present a different ballgame. Although hardware is important, some attention may need to be given to the team. The poorly educated and language handicapped common laborer of the past may have to be trained to operate effectively in this new game. It will cost and as usual the consumer may have to pay the difference.

SOME OBSERVATIONS OF CLOSED MIXING SYSTEMS FOR PESTICIDES

James E. Dewey
Department of Entomology
Cornell University
Ithaca, New York

During the summer of 1978 I was privileged to have a Study Leave which was spent on the West Coast. About 40% of the time was spent studying closed mixing systems for pesticides. Several magazine articles on the subject have given favorable accounts about the system and its advantages. California State officials gave similar favorable accounts, but unfavorable comments were also received, though less well publicized. I was interested in learning more about closed systems so that I might respond more knowledgeably to inquiries that I have had from New York pesticide applicators. Also, if the systems work and have merit, then this information should be available to New York applicators who are interested in increasing the safe use of pesticides. There also have been comments that California has a law on closed systems, therefore New York State should also have one. In 1978 I felt that such a regulation would be premature and I am convinced after my visit.

However, before discussing closed systems and giving my observations of them, I would like to express some concerns on the subject. The first of these is that closed systems mean different things to different people, and most people outside of California have a different view than that expressed in the California regulations. Secondly, California is rather a unique area in its climate, agriculture, amount of pesticides used and a predominance of commercial applicators to apply pesticides. In most states, the grower or his employee is the applicator and not a commercial applicator. A commercial applicator or large grower may be able to afford an expensive sophisticated closed system. A small grower is quite likely to be limited in the amount of use such a system might have and in what he can spend for such a system. Also, the manner in which we are approaching the requirement of use of "Closed Systems" is a concern. Once closed systems are required for diallate, will this be a precedent for more and more pesticides on the RPAR list? This seems to be a way of regulating the pesticide without an amendment of the law or a new regulation. What will the effect on our applicators and other states be if this becomes an operating procedure? I am not sure in my own mind that this is the way to go!

What Does A Closed System Consist Of?

The California closed systems are comprised of four basic operations--penetration of the container without opening by hand; removing the pesticide from the container; metering out the proper amount of pesticide; and finally the transfer of the pesticide into the mix tank. In some instances an optional but desirable mechanism for crushing the can is available.

Penetration of the Pesticide Container

Penetration is usually accomplished either by puncturing the can, usually through the bottom or side of the can with a steel device or by the use of a probe. Probes usually are introduced through the plastic pour spout (Rieke Flex

Spout Closure), through the bung, or through a new opening made specifically for the probe. If introduced through the plastic pour spout, the plastic spout had to be cut out and removed by hand which sometimes causes serious exposure of the worker. Probes are usually made up of a plastic tube or of stainless steel. Usually the probes consist of two tubes, one inside the other--one for rinsing and one for removal of the pesticide. Most of the probes in use must be left in the container until it is completely empty and rinsed. However, a significant improvement has been developed. On some closed systems, the expensive head will detach outside the container while leaving the probe in the container.

Removing the Pesticide From The Container

Removal of the pesticides from the container depends on the mechanism of penetration. If penetration is by a puncturing device, then the pesticide may be removed by simple gravity. The pesticide runs out of the punctured container into a metering device or may be pumped into a measuring device.

If probes are used, some sort of pump or venturi is used to create a positive pressure or a vacuum. Many of the package systems have a separate pump or pumps in the system, rather than using the pump already in the transfer or mixing equipment. In my opinion, the use of positive pressure should be avoided as a safeguard against leaks, blowouts, etc.

Vacuum systems vary from the use of hand operated diaphragm vacuum pumps to small electric vacuum pumps, manifold vacuum from the main engine of the vehicle and venturi systems. Again, the venturi appeared to be by far the most effective and cheapest method of creating the vacuum, particularly if located on the outlet side of the pump.

Means of Measuring the Pesticide

Several means of measuring the pesticide were observed. Usually sight tubes were used on gravity or elevated tanks. Some used a pump with a fixed stroke which moved a known quantity with each stroke and others used a calibrated probe. When calibrated probes were used, the probe should be designed for a specific container of a given size.

Another method observed on at least one piece of equipment was a direct metering device similar to those used for metering water, gasoline, etc. These can be very fast and accurate. The primary objection is that a delayed shut off when the material is being delivered directly to the mix tank will result in a non-correctable error in pesticide delivered.

Many of the mechanisms used appear to be inaccurate for measuring out relatively small quantities of pesticide.

Optional but desirable is the incorporation of a container crusher following the rinse treatment. Only one unit was observed with such a device. However, a few other units had separate crushers which could be used at the mixing station or headquarters.

What Are The Problems As Observed?

In general, the California law is too complex and was premature for the state of the art. Perhaps it was the only way of stimulating ideas and getting underway. Many California growers do not have closed system equipment and do not intend to purchase such equipment. They plan to either pour liquid concentrates themselves or hire commercial applicators for highly toxic materials. The commercial applicators are required to have closed systems in order to purchase restricted pesticides. Most of them have closed system equipment on hand and at the job site, but may not use it except when visited by strangers. The manufacturers, particularly those that built closed systems early, are unhappy because the state has made regulations less stringent with time. Many of the early manufacturers have gone out of business, or are getting out while others have rather high inventories of equipment that probably will never be sold unless drastically altered or purchased by some unknowing person from another state.

Too Complex

Most of the manufactured units sold as a system are too complex. In part, this is because commercial applicators often use more than one material in a mix and frequently need five or six different materials. Thus many of the manufactured units are equipped to handle three to six different chemicals. One unit equipped to handle five different pesticides requires 48 specific steps to start with a new full can of pesticide and meter it into the final mixing tank. Another system which could handle only one pesticide was designed for the farmer but still required 41 different steps for each use. One of the common complaints is that closed systems are more dangerous than pouring the chemical directly into the tank, particularly when much of the help used for this sort of work in California is inexperienced and not able to handle such complex systems.

Lack Durability

Lack of durability has been another major problem. Chemical breakdown has been a particular problem especially with hoses and devices made from or using large amounts of plastics in their equipment. The concentrated pesticides Supracide and Meta-Systox R caused rapid hose deterioration. Some of the metering devices made of plastic and any rubber parts were very short lived. Plastic probes were particularly vulnerable but solder on some of the stainless steel probes also deteriorated when probes were left in the containers. One such case was noted with paraquat. Hose connectors also seem to be a weak point in the systems. No drip, quick coupling couplers should be used to prevent exposure when using closed systems.

Too Slow

Another common complaint was that closed systems were too slow in pesticide delivery. This was particularly true for aerial applicators. Generally the pumps in the closed systems could not move the material fast enough. In some instances the probes and hoses used were too small in diameter. Also some formulations

were particularly difficult to handle, especially those that were viscous like the older formulation of Bravo EC and Comite. The new Bravo 500 (1978) works quite satisfactorily.

One aerial applicator in northern California indicated that he had to put one extra person on his crew to help service the operation, but still increased his ground time. However, this applicator is convinced of the value of the closed system and is presently rebuilding his system so that the materials can be moved faster and the time loss can be overcome.

Expensive

Some of the units are very expensive. The cheapest units observed were $175.00 for a single chemical, one gallon unit and the price exceeded $30,000 with truck and tanks for six chemicals. Probes are usually $200.00 and up. All single assembled systems had some serious shortcoming. However, a satisfactory system could be assembled at a relatively low cost without the shortcomings mentioned.

As indicated earlier, some of the units lack accuracy, especially for measuring small amounts. Only one system was set up to handle wettable powders, and with this system the package had to be opened and emptied into the receiving box.

Probes A Major Problem

The most common complaint with closed systems seemed to be centered around the probes. Everyone seemed to have a complaint about them. Most were very expensive and once introduced into a container, had to be left until the container was empty. Some soon lost the calibration markings for measuring and others developed leaks. Most agree that containers should come already fitted with a standard closure and a probe in the can which would add an estimated cost of about $.40 per 5 gallon can. Industry objected to this requirement in California but companies now are evidently expressing some interest because other states are considering regulations for closed systems and containers. EPA has recently indicated a possible requirement for standard openings and probes for all pesticide containers so that closed systems could be used. At least two companies are working on heads which disconnect from probes so probes can be left in the cans while the head is being used on other containers. One manufacturer is marketing probes and a coupler for pesticide containers.

Manifold Vacuum A Problem

Another observed problem was the use of manifold vacuum for pumping the pesticide from the container into the metering device and into the mixing tank. Cases were reported where the pesticide was sucked into the engine causing the engine to be ruined. Also, the vapor that is sucked through the system and out through the exhaust when manifold vacuum systems are used may be dangerous. Injector or venturi types of transfer systems thus are probably better than manifold vacuum types.

What Should A Closed Mixing System Be?

The advantages of closed mixing systems are many provided that the system is effective. One aerial applicator is convinced of the increased safety of the system, indicating that cases of pesticide-related illness have been reduced from 5 to 6 per year down to none since the closed system was added. What characteristics should a good system have? Based on my observations, the closed mixing system should be:

1) Simple - simply constructed, simple to operate with a minimum of directions to follow, and easy enough to use that it is used for all pesticides, toxic or not.

2) Durable - the equipment must be able to withstand continual use. Breakdown causes alternate procedures and these frequently lead to other problems--leaks, contamination of repairmen, etc. Probes should be durable, lightweight and resistant to pesticide concentrates and the solvents in them and equipped with a "breakaway head" at least until they are a part of the container. If probes are to be a part of the pesticide container, they should be made of a lightweight, durable material such as urethane or similar material that will withstand the solvents in the chemical used in that can, and should provide for rinsing the container when empty. Probes should be thoroughly tested prior to use.

3) Fast - the system should have fast delivery so operations are not delayed.

4) A vacuum-operated rather than positive pressure. I believe the venturi system to be the lowest cost, simplest, and most effective system for developing the vacuum.

5) Easy to use - complex procedures reduce acceptance and increase the risk of accidents and errors.

6) Flexible - system should be adaptable to many pesticides.

7) Standardized - all pesticide containers should have standardized closures and equipped with probes of a standard design so as to permit both removal of the pesticide and rinsing of the can.

Conclusions

Closed mixing systems for pesticides have great promise and can make a great contribution to the safety of the use of pesticides. Certainly effective systems would protect applicators who presently undergo the greatest exposure. However, systems are presently under development and the most effective systems are probably not yet available. Regulating closed systems into use may prevent further development and would be a mistake. Proceeding on an educational basis and allowing people to try different and innovative methods would allow development and perfecting closed systems to serve the best interests of all. The development of the various parts of a closed system should be done separately in a stepwise manner. For example -- the rinse feature might be a separate step, and perhaps develop a system for liquids first and then later for wettable powders. By

building up a closed system in a stepwise manner a system will be available to handle all pesticides used by the applicator. Then all pesticides should and probably would be handled through the system.

Discussion

Enforcing closed system use too rapidly would be a mistake and may cause a backlash against closed systems.

The California systems and regulations are designed for commercial applicators. Diallate is applied primarily by farmers so some of the California experience will not apply to diallate.

Concern was expressed that requiring the use of closed systems for diallate may set an undesirable precedent. Closed systems may become required for pesticides which are not toxic enough to need closed systems. Several people questioned whether diallate toxicity and diallate exposure to applicators was great enough to justify a closed system requirement. The group was in general agreement that closed systems were preferable to losing the availability of diallate.

Types of Closed Systems Used in the Red River Valley

George Bowman
North American Pump Corporation
Grand Forks, ND

Awareness of the need to avoid pesticide exposure has increased greatly since the 1950s. Most large custom and private operators in the Grand Forks area are presently using some form of closed system for pesticide handling.

Some of the available types of closed systems are:

1) Refiller system - A venturi is used to suck the pesticide from a pesticide barrel and water from a water tank simultaneously. They are delivered to the sprayer tank. A meter is used to measure the amount of pesticide delivered. Meters can be used to measure non-diluted pesticide but the meter should be selected for tolerance to the pesticide being used. Hoses also must be matched to the pesticide being used.

2) Nurse tank system - A hand pump is used to transfer the pesticide from a holding tank to the sprayer tank.

3) A "California Closed System" - This system costs $3000 and takes 34 steps to operate. The system is too expensive and too complex for customers in the Red River Valley so none of these systems were sold.

4) Bag system - The pesticide is enclosed in a water soluble bag which dissolves after being placed in the spray tank.

5) Hand pump system - The pesticide is transferred from a pesticide container into a 15 gallon calibrated metering tank. The pump which fills the spray tank with water also sucks the pesticide from the metering tank into the spray tank.

6) Electric pump - A 12 volt-operated pump is coupled with a meter so that the desired amount of pesticide is injected into the discharge line of the water pump. Meters with automatic shut off are available.

7) Suction type system - A probe is placed in pesticide container with a meter on the probe. A centrifugal pump fills the spray tank with water and sucks the pesticide through the meter.

Farmer Viewpoints on Closed Systems

Manvel Green
St. Thomas, ND

Farmer acceptance of closed systems can be achieved through demonstrating that closed systems provide improvements in accuracy, time saving, less waste, greater versatility and greater safety. The system should be economical and simple.

Mike Warner
Halstad, MN

Attempting to force farmer acceptance of closed systems probably won't work. Demonstrating that closed systems will save time and money will get farmers to accept closed systems. A simple system will have more acceptance than a complex system. Complex systems mean more maintenance and maintenance means lost time. A closed system costing about $300 to $500 will be accepted. More expensive systems will have less acceptance.

Reports of Working Groups

James Dewey and Steve Miller
served as resource persons and floated
from group to group

Working Group A - Definition of Closed System.

Participants: George Sinner, Glynadee Edwards, Robert Brazelton, William Jacobs, Galen Schroeder, Alan Dexter, Richard Behrens, Allen Wiese.

Definition - A liquid pesticide closed system is a system for removing a pesticide from its original container, rinsing the emptied container and transferring the pesticide and rinse solution to the application equipment in a manner that prevents harmful human exposure.

This definition is a modification of the California definition which is given in Attachment 1 with the Robert Brazelton section. The California definition states that closed systems will "prevent exposure." This was considered too restrictive so this working group substituted "prevents harmful human exposure." The question of what is harmful will have to be established by EPA and other concerned agencies.

Essential Components of a Closed System.

1. Container entry mechanism

    a. probe through container port
    b. puncture

2. Pesticide extraction from the container

    a. gravity flow
    b. suction

3. Transfer capability

    a. pump or venturi
    b. gravity
    c. other methods

4. Metering capability

    a. digital flow measuring device
    b. sight gauge
    c. calibrated probe
    d. direct volume measurement

5. Rinse system - liquid injection to flush original container, capture rinse solution, and transfer to application equipment.

Working Group B - Expected Acceptance of Closed Systems for Diallate.

Participants: Manvel Green, Dave Hanson, George Bowman, LeRoy Schaffner, Ralph Whitesides, Charles Gates, Larry Mitich, Gene Heikes, Leon Wrage.

Four groups or organizations were identified and the following question was asked for each group: Why would (farmers, chemical companies, container manufacturers or the EPA) be willing to accept a closed system for the application of diallate. The response of each of these groups, as interpreted by Committee B, is summarized under each heading in this paper.

FARMERS

Farmers may be willing to accept a closed system for diallate (EC) for the following reasons. Reasons are listed in order of estimated importance to the farmer.

1) Show that closed systems are more economical than present systems; give increased accuracy; are versatile; cause less waste of time, fuel, pesticides, etc.; result in savings; and are simple.

2) An effective educational program which clearly and effectively presented the advantages of a closed system.

3) An ultimatum from pesticide regulators stating that closed systems must be used to handle diallate EC or the product will be removed from the marketplace.

4) Most farmers would purchase a relatively inexpensive closed system, and continue to use diallate EC, rather than make a larger capital expenditure for granular application equipment to use the granular form of diallate.

5) Bulk distribution of pesticides should reduce the costs of pesticides. Some type of closed system will be needed to handle bulk pesticides efficiently so this may stimulate and facilitate acceptance of closed systems.

6) A closed system should be as economical as conventional methods for farmers who treat a small acreage with diallate. The impact of closed systems would be smaller for large acreage farmers because many are already partially equipped to handle liquids in bulk.

7) A closed system is safer than conventional methods. Safety ranks last in this list because diallate has been used for a long time. Growers feel comfortable with it, and do not consider it to be very dangerous.

CHEMICAL COMPANIES

Chemical companies may be willing to accept a closed system for diallate for the following reasons.

1) Economics. If closed systems were the only route possible to keep diallate on the market.

2) Company reputation. Accepting closed systems would demonstrate that the company is interested in innovative techniques and is not afraid to change if something new comes along; demonstrate desire to improve application techniques so that efficacy of the product is improved; demonstrate desire to increase convenience in using the product; and demonstrate that the company is conscientious and concerned about the safety of the product they manufacture.

3) Product liability. Closed systems may reduce the chances of liability claims against the manufacturer.

CONTAINER MANUFACTURERS

Container manufacturers may be willing to accept a closed system for diallate (EC) if the chemical companies that produce diallate placed an order with the container manufacturer with specifications that called for containers adapted to be used in closed systems. The principles of business come into play here so that a supplier changes the product to suit the needs of the user. The impact of closed systems for diallate should have limited effect on container manufacturers unless the necessary materials or technologies are not available to produce the desired product.

This working group strongly suggested that container closures be standardized throughout the pesticide industry. However, the type of container should probably be left to the manufacturers because the group had no desire to stifle creativity and competitiveness in the container industry. The level of acceptance of closed systems may depend in part on some standardization of container closures.

ENVIRONMENTAL PROTECTION AGENCY (EPA)

The EPA may be willing to accept a closed system for diallate (EC) if closed systems were shown to be safer for those who handle pesticides (diallate) and to lower the possibility of spills and thus provide a higher level of safety for the environment (including man). Requiring closed systems for diallate may set a precedent and provide a new avenue to permit registration of pesticides that undergo the RPAR process.

Discussion

Many of the people in attendance at the Workshop doubted that the risk from diallate use is high enough to justify cancellation of registered use of Avadex EC or the requirement for a closed system. However, the group would prefer use of closed systems to cancellation of registered uses.

The group generally agreed that a closed system requirement should be phased in over a period of years (at least two) to allow system technology to develop and be effectively used.

Working Group C - Impact of Adopting Closed Systems for Diallate.

Participants: Mike Warner, Albert Czajkowski, Frank Serdy, Cliff Nolan, C. L. Smith, Oliver Strand, Stan Fertig, Ed Schweizer, Allan Cattanach.

Group C estimated the economic impact of adoption of various closed systems on farmers, chemical companies and container manufacturers; and the effect of closed system adoption on custom applicators, application accuracy and effect on the environment. This objective was broken down into components and will be discussed separately.

A. Estimated economic impact to the farmer of a closed system requirement for diallate.

 1. It is felt that closed system equipment costing less than $500 will be acceptable to most diallate users.

 2. Farmers who use diallate now will probably continue using with the closed system requirement.

 3. Closed system equipment can help reduce waste which is an economic benefit to the farmer.

 4. Small farmers are less likely to use a closed system because of the greater cost per volume of pesticide used.

 5. A farmer must be convinced that a closed system is a better and easier way to handle pesticides. This can be accomplished best through education rather than making system mandatory.

 6. To obtain widespread usage, the farmer must be convinced that a closed system has additional benefits over and above reduced exposure.

B. Estimated impact of a closed system requirement for diallate on custom applicators.

 1. Many custom applicators are using systems for handling pesticides that may qualify as closed systems; therefore, a closed system requirement has potentially less negative impact on custom applicators than farmers.

 2. Closed system equipment with provisions for rinsing may encourage custom applicators to be more diligent in rinsing containers.

C. The effect of closed systems on the accuracy of diallate application.

 1. Due to the relatively high expertise sugarbeet growers in the Red River Valley have in applying pesticides, improved accuracy in application may not be a major benefit of closed systems.

 2. A metering device associated with a closed system could improve accuracy of mixing and loading.

D. Environmental aspects of closed system handling of diallate.

1. Closed systems should reduce spills.

2. Closed systems could encourage rinsing containers.

a. A closed system could include a provision for rinsing.

b. EPA requires triple rinsing of containers. This working group stated that including a triple rinse requirement as part of a closed system was undesirable and unnecessary.

General impact of various closed systems on farmers, chemical companies and container manufacturers:

A. Impact of closed systems on farmers.

1. Minimum problems anticipated with large farmers.

2. May be an economic and convenience hardship to some small farmers, due to the small gallonages of diallate used.

3. Hired help with minimum education can have problems using closed systems. The system must be simple, both for unskilled labor and for reduced maintenance.

B. Impact of closed systems on chemical companies and container manufacturers.

1. The main impact would be in the area of container standardization. This is especially critical in the area of container openings, including spouts, threads, bungs, etc. Perhaps standards should be set by a national association such as National Agricultural Chemicals Association.

2. Probes built into containers. This system has potential, but would probably be more expensive than standard openings.

3. Many farmers desire to have their own tanks filled with herbicides from a central location (a bulk handling system). This would stimulate closed system acceptance but may cause problems with product integrity and contamination.

SUMMARY

A closed system should be presented as a suggested method to handle pesticides rather than made mandatory. Closed systems should be presented as a method to further minimize risks in addition to use of gloves, goggles, coveralls, etc.

Working Group D - Reduction in Diallate Exposure by Closed Systems.

Participants: Alvin Hansen, Harry Frazier, Louis Lynn, Stuart Frear, Tom Schwartz, John Nalewaja, Gene Arnold

1. Evaluate expected reduction in exposure by closed systems.

Use of rubber gloves reduces exposure to diallate by approximately 90%. This reduction may be sufficient to eliminate risk of alleged oncogenicity due to diallate. An additional 6-fold reduction in exposure to face and neck may be obtained with closed systems. Inhalation does not appear to represent a significant route of exposure with diallate EC. Much reduction in exposure can be accomplished through education as to importance of cleanliness, neatness and observance of the label during application. Any system should possess adaptability, efficiency, simplicity, and cost effectiveness. Development of closed systems should proceed in an orderly manner to allow development and incorporation of new technology. The incorporation of rigid requirements for closed systems into regulations may be unwise. Rigid regulations may inhibit further development of closed systems technology.

2. List advantages and disadvantages of closed systems relative to exposure.

A. Pesticide exposure may be reduced by closed systems in certain situations.

1. Closed systems will reduce exposure to pesticides during spray tank filling.

2. Closed systems will minimize handling of heavy cans and reduce pesticide spills.

3. Closed systems will improve ease of rinsing.

4. Large errors in mixing and loading would be unlikely with closed systems having accurate metering. Thus excessive exposure from such errors would be prevented.

B. Pesticide exposure may be increased by closed systems in certain situations.

1. Complex closed systems may require maintenance. High levels of pesticide exposure could occur during maintenance.

2. People working with closed systems are less likely to wear protective clothing. Any spills, equipment problems, or other accidents may cause more exposure to the applicator than a non-closed system.

3. Removing closed system probe from a partially empty can may cause a high level of exposure.

4. Storage of left over pesticide and partially empty cans can cause unstable stacking which may cause leaks or spills.

5. A slow system may cause an applicator to try to by-pass the system in an unsafe manner.

6. Lack of container standardization may increase exposure by causing the closed system to leak or fail because of a poor fit.

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